Canon Envirothon

Water Quality Study Guide

Louisiana Department of Environmental Quality
Office of Environmental Assessment
Water Quality Assessment Division

2005

Introduction

Abundant and good quality water is arguably the most important natural resource in the world. Most other natural resources such as oil, natural gas, coal, even plants and animals, while certainly important, can generally be replaced by other products or species. But fresh water may be unique in that there is no replacement for it in the world. Fresh, drinkable water cannot be readily manufactured from its basic components of hydrogen and oxygen. Nor can it be cheaply obtained from saltwater in the oceans. Severely polluted water can be cleaned, but only at high cost. Humans can go for weeks without food but will die within days without water. Likewise, plants and animals depend on good quality water for their survival. Take away fresh water or pollute it to the point it can no longer be used and plants, animals, and humans that depend on it will have to move or die. This may sound extreme or even alarmist but taken to its potential endpoints it is all true. Fortunately, there are ways everyone can take responsibility for conserving and protecting this most precious natural resource.

Water Quantity and Availability

Most people know that roughly 71 % of the earth's surface is covered with water. Just looking at the all the oceans surrounding the continents makes one wonder, what's all the worry about safe drinking water? Here's why. There is an estimated 280 billion liters of water for every person living in the world today (based on 5 billion people). That is certainly a lot of water. But, of that huge amount some 97% (271.6 billion liters/person) is unfit to drink because it is too salty. This salty water can be desalinated, but the process is expensive and only currently used in extremely arid (and wealthy) regions of the world. This leaves 8.4 billion liters per person.

Of these 8.4 billion liters some 80%, 6.72 billion liters, is frozen at the poles and not readily available for consumption. This frozen water may be even more inaccessible than the salt water discussed earlier because to access it would take enormous ships to haul the ice to warmer climates where it could melt and be used. This leaves 1.68 billion liters per person.

Next we need to reduce these 1.68 billion liters by 99.5% to account for all the water that is too far underground to be of use, is trapped in soil, or is too polluted to be drinkable. This leaves 8.4 million liters per person in the world, which may seem like a lot. However, 8.4 million liters is theoretically more than a person requires in a lifetime. Another way to look at it is that only 0.00003 percent of all the water in the world is potable (drinkable) water.

Still not convinced? In Louisiana most people get there drinking water from underground sources. Many farmers and industries also use groundwater for growing crops or manufacturing chemicals and other products. In fact, so many people are using Louisiana's groundwater that the aquifers are literally beginning to run out of water in some parts of the state. We have not reached a crisis yet but if Louisiana does not begin to manage its water resources more carefully we could be in big trouble.

In south Louisiana many people get their drinking water from surface water bodies including the Mississippi River. While these are generally adequate sources of water, they run into additional problems with contamination. As a result, surface water supplies of water have to be carefully treated to remove sediments, bacteria, and chemicals that may cause human health or aesthetic problems. No one wants to drink muddy water. More information on drinking water can be found at: http://www.epa.gov/safewater/kids/, http://esa21.kennesaw.edu/modules/water/drink-water-trt/drink-water-trt-hist-epa.pdf.

More resources on water quantity and quality:

http://www.yearofcleanwater.org/,
http://www.deq.louisiana.gov/assistance/educate/index.htm#Water

Groundwater in Louisiana

Louisiana receives an average of 62 inches of rain each year. Precipitation in the form of rain, hail, sleet, or snow flows into lakes, streams, bayous, rivers, and oceans. This process is called runoff. It also seeps into underground storage areas, known as aquifers, through a process called percolation. Aquifers are underground formations of sand and gravel that contain water. This water is called ground water.

Approximately two-thirds of Louisiana residents get their drinking water from ground water, while one-third of Louisiana residents get their drinking water from surface water sources. The water that flows through aquifers contains very little bacteria and is naturally filtered by passing through the sand layers. Because the water in aquifers is naturally filtered, it requires very little treatment and is typically an excellent source of clean drinking water.

To use ground water as drinking water, wells are drilled into the aquifer and the water is pumped out of the ground and into treatment and distribution systems. Aquifers are refilled by precipitation flowing into the ground from the land above. The land can be covered with soil and trees or with marshes and swamps, which absorb and store water that later slowly drains into aquifers. It may take hundreds of years for water to enter the recharge areas and flow through the aquifers.

The quantity of water in the aquifer is affected by precipitation levels and activities in the recharge areas. When precipitation levels are low, as during droughts, the water levels in an aquifer may drop, reducing the amount of water available to everyone, including those who use it for drinking water. Less water may also reach the aquifer if parking lots, highways and other development replace the natural land surface in recharge areas. There isn't much you can do to ensure adequate precipitation for recharging aquifers, however development in recharge areas can utilize technologies that minimize impervious areas, allowing more water to reach the aquifers through the recharge areas.

Not only is it important to safeguard the quantity of water in aquifers; the quality must also be protected. Ground water may become contaminated from a variety of sources including leaking storage tanks, whether above or underground. Some common household products that we use contain components that could also potentially harm aquifers. When these household chemicals are used or disposed of improperly, they could enter and contaminate an aquifer. These products include: gasoline, antifreeze, paint, paint thinner, drain cleaners, motor oil, and pesticides.

It is much easier to prevent contamination than to clean it up. Some tips to help prevent contamination of your ground water include using cleaning products that will not harm the environment, following directions for proper use and disposal of pesticides and other harmful products, and recycling used oil.

More information on groundwater in Louisiana can be found at: http://www.deq.louisiana.gov/evaluation/aeps/.

Water Chemistry Basics

How do we measure water quality? What is clean water? What is polluted water?

Natural, unpolluted water contains many substances such as minerals and bacteria. Some of these are essential for good health, but in large quantities, they can be harmful to human heath and to aquatic organisms. In order to protect human and aquatic life, the Water Quality Assessment Division of the Louisiana Department of Environmental Quality (LDEQ) establishes water quality standards. Water quality standards consist of values for various substances in water in order to protect or maintain designated uses such as swimming and fishing. The designated uses of Louisiana's waters include:

- Swimming
- Boating
- Fish and wildlife propagation
- Drinking water supply
- Oyster harvesting
- Agriculture
- Outstanding natural resources (Scenic Rivers)

We measure water quality in terms of its chemical, physical, and biological characteristics. If these do not meet the water quality standards the water is considered polluted. Described below are some of the characteristics we measure.

Dissolved Oxygen

Oxygen gets into the water from the air and is released by plants that grow in the water. Fish and other organisms that live in water need dissolved oxygen to survive and reproduce. If dissolved oxygen levels drop to very low levels, aquatic organisms become unable to reproduce and can die. In Louisiana waters, dissolved oxygen levels range between 3 and 12 parts per million.

Some of the factors that affect the amount of oxygen dissolved in water include:

- Temperature (warmer water contains less oxygen)
- Velocity (rapidly flowing water absorbs more oxygen)
- Turbulence (higher turbulence = higher oxygen content)
- Plants in the water (photosynthesis releases oxygen)
- Decaying materials in the water (decomposition of dead algae leaves, and wastes uses up oxygen)
- Shading of a stream (affects temperature and photosynthesis, thus oxygen level)
- Depth (deeper water = lower oxygen content)

Temperature

All aquatic organisms require certain temperatures for health and reproduction. If the temperature of the water falls below or rises above the ideal range, organisms may become stressed and unable to reproduce. In very warm temperatures, fish may become more vulnerable to disease and other pollutants. In addition, other aquatic organisms upon which they feed may become less plentiful during extreme temperature changes.

In Louisiana waters, temperature ranges between 32 degrees Fahrenheit in the winter and 90 degrees in the summer. The maximum temperature allowed by the water quality standards is 95 degrees Fahrenheit.

pH

pH is an indicator of whether water or a solution is acidic or basic. pH is a measure of hydrogen ion activity in water, and can range from 0 to 14, with normal measurements ranging from 6 to 9 standard units. A pH below 7 is acidic, and a pH above 7 is basic.

Just like with temperature and dissolved oxygen, aquatic organisms have specific requirements with regard to pH. pH can play a role in determining the size and makeup of the aquatic community. In general, low pH waters have fewer species and smaller populations of aquatic organisms. pH also affects other chemical processes that occur in water. For instance, in low pH waters, metals become toxic to aquatic organisms.

Nutrients

The nutrients commonly found in water are nitrogen and phosphorus. These are the same nutrients found in fertilizers used on food crops and flowering plants, and algae and aquatic plants utilize these nutrients in the same way terrestrial plants use nutrients for growth. Too much nutrient in surface waters can cause excessive algae and grass production, which in turn can cause unwanted conditions in a water body. Excessive algae growth produces the pea soup color in lakes and ponds. In addition, when these algae die and begin decomposing in the water, a sudden decrease in dissolved oxygen levels can occur, causing fish kills.

The sources of nitrogen in water include the air, sewage, animal wastes, artificial fertilizers, and plant and animal matter. Sources of phosphorous are sewage, animal wastes, artificial fertilizers, and soil that washes into the water. The concentration of inorganic nitrogen in relatively unpolluted streams in Louisiana ranges from 0.03 to 0.18 part per million, and in polluted streams it can be as high as 0.50 part per million. The concentration of phosphorous in unpolluted Louisiana streams ranges from .05 to .10 part per million, and in polluted streams phosphorus can be as high as 1.0 part per million. Louisiana has not yet established numerical water quality standards for nutrients.

Turbidity

Turbidity refers to the cloudiness of water and is a measure of the amount of light that penetrates the sample of water. The cloudier the water, the more substances there are suspended in the water. High turbidity can inhibit photosynthesis in aquatic plants and makes the water look dirty. In addition, high amounts of suspended particles in water can be harmful to fish and other aquatic organisms.

In Louisiana water, turbidity varies widely, but in the least polluted streams and in lakes turbidity ranges from below 10 units of measure to 25 units. In the Mississippi River, the average turbidity is near 50 units but can go as high as 150 units.

Bacteria

Bacteria occur naturally throughout our environment; some are beneficial, and some can cause disease in humans and animals. We measure bacteria in water to determine if there may be disease-causing organisms present in the water. We test for a group of bacteria called fecal coliforms, which are bacteria found in the intestines of warm-blooded animals. If fecal coliforms are found in the water in large numbers, then it is likely that other organisms which can cause illness are present as well. The water quality standard used most often for swimming is 400 bacteria per 100 milliliters of water (equivalent to about one glassful).

Bacteria in the water does not affect the quality of fish nor do they make the fish unsuitable for human consumption. However, shellfish taken from polluted waters should not be eaten raw.

Metals

Metals measured in water include arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc. These metals are natural elements of the earth, but they also enter surface waters from man's activities. In elevated concentrations, these metals can be harmful to fish and other aquatic organisms. These metals can also accumulate in fish in polluted waters and cause health problems in humans that eat those fish.

More resources on water chemistry:

http://www.deq.louisiana.gov/assistance/educate/index.htm#Water

Water and the Hydrologic Cycle

Water moves through the environment in a pattern commonly understood as the hydrologic cycle. However, this cycle has many side branches that can redirect the water, temporarily hold it in one of several places, or even lock it up for centuries. The following sites provide details on how the hydrologic cycle works:
http://www.mhhe.com/earthsci/geology/mcconnell/demo/hycycle.htm
http://www.und.nodak.edu/instruct/eng/fkarner/pages/cycle.htm

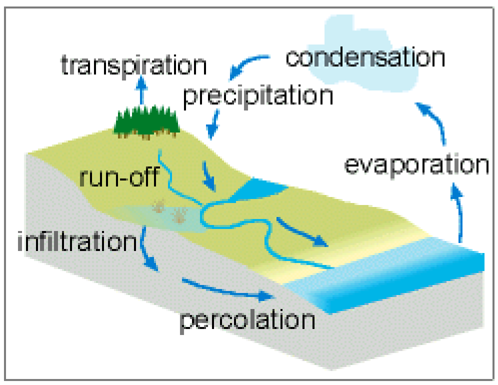

Figure 1 Basic diagram of hydrologic cycle

Water and Geomorphology

When rain falls on the land it generally behaves in predictable patterns. Some of the water soaks into the ground, some runs off slowly through natural streams, and some may run off quickly across roads, parking lots, and buildings. Pervious surfaces are areas where rainwater is able to soak into the ground or runoff slowly into natural streams. These usually consist of exposed soil, grassy areas, fields and pastures. Pervious surfaces, allow rainwater to move more slowly through the system, while allowing some of the water to soak in. This actually works to reduce flooding in many areas. Impervious surfaces on the other hand include roads, parking lots, and buildings. These surfaces cause rainwater to rapidly fill area streams often causing flooding because none of the water is able to soak in. In addition, the water simply moves faster and is often funneled off of roads or parking lots directly into area ditches and streams. While the area where the rain falls may not flood, downstream areas often have significant flooding as more and more water backs up because there is no place for all the water to go. More

information on pervious and impervious surfaces can be found at:
http://www.vbco.org/planningeduc0004.asp,
http://www.uwsp.edu/cnr/landcenter/pdffiles/EnvironmentalIndicatorFactSheet.pdf,
http://chesapeake.towson.edu/landscape/impervious/all_what_imp.asp.

Streams and rivers form watersheds which carry water from high points on the land to lower areas. In most areas of the United States watersheds ultimately lead to the Gulf of Mexico, the Atlantic Ocean, or the Pacific Ocean. Watersheds can be as small the drainage area for a bayou through town or as large as the Mississippi River watershed which covers all or part of 30 States.

A watershed generally consists of the headwaters which are found at the highest elevation in a given area. Water flows from the headwaters through various tributaries to the middle reaches of a watershed. As small streams gather together they former larger and larger rivers until they ultimately reach something the size of the Red, Sabine, Ouachita, Mermentau, Vermilion, Pearl, or even the Mississippi rivers. Where larger rivers empty into the Gulf of Mexico or oceans they often form deltas. Deltas consist of small branches, or distributaries, that branch off from the larger river and tend to move over time if not constricted by artificial levees and dikes. The Mississippi River delta has moved from approximately Lafayette to Lake Pontchartrain over the course of about 7,000 years, forming seven distinct deltas in the process. However, the Mississippi is now closely controlled by levees and the Old River Control Structure near Simmesport, Louisiana. This was done to prevent flooding and to prevent the Mississippi River from abandoning its current channel in favor of the Atchafalaya River. While important for the protection of homes and cities along the river, these levees are also largely responsible for the ongoing loss of Louisiana’s coastal marshes.

Figure 2 Mississippi River delta from space

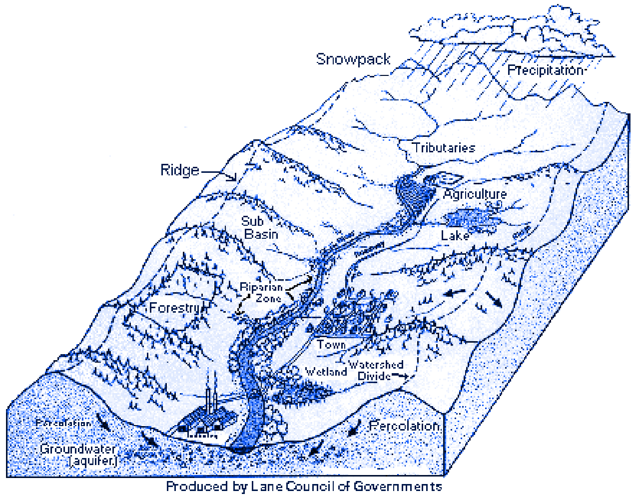

Figure 3 Watershed diagram

More detailed information on watersheds can be found at the following sites: http://www.ctic.purdue.edu/KYW/glossary/whatisaws.html, http://www.epa.gov/owow/watershed/whatis.html

Smaller streams and bayous often form estuaries where they meet the ocean or Gulf of Mexico. An estuary is an area where fresh and salt water mix forming a rich gumbo of plant and animal life. All of south Louisiana consists of estuaries formed by the mingling of freshwater rivers like the Sabine, Calcasieu, Mermentau, Vermilion, Atchafalaya, and Pearl with saltwater moving north with the tides from the Gulf of Mexico. Bayou Lafourche, located south of New Orleans, forms the Barataria Terrebonne Estuary, which has been designated for extra protection as the Barataria Terrebonne National Estuary Program. More information on estuaries can be found at: http://www.btnep.org/, http://www.epa.gov/nep/about1.htm, http://www.estuaries.org/.

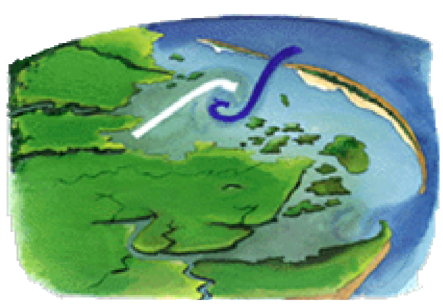

Figure 4 Diagram of an estuary

Wetlands, as you can imagine, are wet lands. They can be forested with giant cypress and tupelo gum or full of grass and sedges. Surprisingly, they can be dry much of the year but fill with water during rainy seasons. Other wetlands are always full of water. Wetlands are usually low lying areas where water accumulates at least during some periods of the year faster than it runs off or evaporates. Specialized plants and animals reside in wetland areas, often making them very productive both in terms of the number of species and the sheer volume of plants growing there.

Figure 5 Grassy marsh

Figure 6 Bottomland forested swamp

Not all wetlands are always wet. In order to be considered a wetland the area only has to be flooded periodically in order to support the specialized organisms that normally reside in wetlands. In addition to the coastal estuaries of Louisiana, which are also wetlands, many of Louisiana's natural and man-made lakes are surrounded by wetlands because the land is so low and saturated with water. Catahoula Lake and the surrounding area in central Louisiana is a large wetland. The Atchafalaya Basin in south central Louisiana is one of the largest wetlands in the United States. It consists of a maze of interconnected bayous, lakes and small rivers, all fed at one time by the overflow of the Atchafalaya River. Now however, like the Mississippi the Atchafalaya River is closely hemmed in by flood control levees. These levees cut the river off from the forested wetlands it once nourished. The Atchafalaya River is actually a distributary of the Red and Mississippi Rivers, flowing from the confluence of these two rivers near Simmesport, Louisiana.

Vernal pools are a small form of wetland that only hold water for short periods of time. But in that short period many animals like frogs, toads, salamanders, and insects can rapidly locate the pool, breed, hatch, and grow into adults before once again dispersing into the surrounding areas when the pool dries up. More information on wetlands can be found at: http://www.epa.gov/owow/wetlands/, http://www.nwrc.usgs.gov/.

Figure 7 An eastern vernal pool (Don't be confused by the snow, this is obviously not Louisiana). Inset shows a marbled salamander that could live in the pool.

Water Quality Management in Louisiana

Water quality management in Louisiana is a team effort. There are hundreds of scientists and engineers that work together to ensure Louisiana has clean water for all its varied uses both now and in the future. Many of these people work with the Louisiana Department of Environmental Quality (LDEQ); however, others are with the Louisiana Department of Natural Resources, the Louisiana Department of Health and Hospitals, the Louisiana Department of Agriculture and Forestry, and the Louisiana Department of Transportation and Development. Still others work for the various universities in Louisiana, conducting research on how best to protect and improve Louisiana's water resources. There are also many engineers and scientists who work for municipalities, industry and consulting firms. Their jobs are to work with the various State and Federal agencies in ensuring that discharges from these facilities will not harm water quality in Louisiana.

Water Quality Standards and Assessment

The section on water chemistry provided an overview of the various aspects of water that are important. The standards or criteria described in that section are determined by the LDEQ and written into State regulations in what is known as the Louisiana Environmental Regulatory Code (ERC). Louisiana's ERC regulations for water can be found at: http://www.deq.louisiana.gov/planning/regs/title33/33v09.doc. The same group that determines these criteria is also responsible for conducting assessments or tests to determine if these criteria are being met. Another group within LDEQ samples the water in approximately 130 locations around the state every month. In most cases the water is tested for about 20 different parameters or chemicals found in the water. Each of these parameters and locations has their own criteria that are used to determine if the water is meeting its designated uses, which were outlined above. More information on water quality standards, monitoring and assessment can be found in the 2004 Water Quality Integrated Report found at: http://www.deq.louisiana.gov/planning/305b/2004/index.htm. Part III of this document provides an overview of Louisiana's water quality assessment process.

Water Quality Permitting of Point Source Discharges

Point source discharges are releases of wastewater from discreet pipes. Wastewater may originate from large industrial or petrochemical facilities. It may also be discharged from large municipal sewage treatment plants or small neighborhood or business wastewater facilities. In each case the discharger must have a permit from the LDEQ to ensure that the discharge will not harm or impair the water quality of the water body receiving the discharge. LDEQ administers and reviews the Louisiana Surface Water Quality Standards found in the Louisiana Environmental Regulatory Code, Title 33 Louisiana Administrative Code, Part IX, Chapter 11. LDEQ is also charged with the responsibility of maintaining and enhancing the waters of the State through the permit process. Permitting regulations and implementation plans establish procedures to effectively incorporate the water quality standards into wastewater discharge permits. Although all applications for permits to discharge wastewaters are considered on a case-by-case basis, LDEQ believes that a consistent approach to application reviews is important. Draft water quality permits are reviewed by the facility requesting the permit and subject to a public review period to ensure citizens in the area have a chance to comment on the facility. This public review period is a chance for local citizens to get involved with the permitting process, and thereby have some impact what happens in their area.

Water Quality and Nonpoint Source Pollution

In addition to point sources of water pollution, a second and larger source of pollution is what's known as nonpoint source (NPS) pollution. NPS pollution comes from many different sources but the common feature is that it results from the runoff of rainwater from the land. What that land is like or used for determines the possible pollutants the water picks up as it moves into streams and lakes. Agricultural land frequently causes high levels of pesticides, fertilizers, and soil or sediment to be picked up by stormwater. When these pollutants get into streams or lakes they can cause problems for fish, other organisms, or people who use those water bodies. Runoff from urban areas like roads and parking lots often have high levels of oil, gasoline, metals, and other chemical from the cars and truck using them. Runoff from suburban lawns and parks, like agricultural areas, often contains pesticides, fertilizers, and sediments. Taken together, NPS pollution now accounts for over half of the water pollution in Louisiana and the Nation. More information on NPS, the different sources and forms of NPS pollution, and ways to prevent it can be found at: http://nonpoint.deq.state.la.us/.

Water Quality Testing in Louisiana

Biological Testing

A wide variety of specialized techniques and equipment are used by LDEQ scientists to test water quality in Louisiana. One of the simplest and more interesting techniques is to use the macroinvertebrate life of a water body to determine if the stream or lake is healthy enough to support a good aquatic community. Macroinvertebrates are organisms that are large enough to see with the naked eye (macro) and do not contain a vertebral column (invertebrate or no backbone). Most macroinvertebrates used for this process are aquatic larval insects like stoneflies, mayflies, dragonflies and damselflies. Other macroinvertebrates that can be used include crayfish, clams, snails, leaches, and worms. Different types of macroinvertebrates have different tolerances toward water pollution. More information on this technique as well as a chart showing these organisms can be found at: http://www.deq.louisiana.gov/assistance/educate/waterbug.htm.

Chemical Testing

While macroinvertebrate sampling is helpful, LDEQ primarily uses water quality sampling and field or laboratory analysis to determine the quality of Louisiana waters. This testing is done with a variety of sampling equipment including electronic water meters, water sampling devices, sediment sampling devices, flow meters, and other more specialized equipment. (All equipment pictures were taken from Ricky Hydrological Company online catalogue. http://www.rickly.com/wqi/water_quality_instruments.htm)

Electronic sampling devices are widely used to measure parameters such as dissolved oxygen, pH, salinity, conductivity, and temperature. There are several companies that make different versions but they all work in the same basic fashion. These devices work by lowering an electronic probe or group of probes into the water. The probes are attached to a small box-like device that allows the user to read the results for the various parameters. These devices must be carefully maintained and calibrated in order to ensure accurate measurements are obtained.

Figure 8 YSI electronic water meter

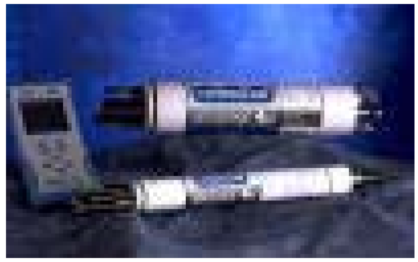

Figure 9 Hydrolab electronic water meter

Water sampling devices usually consist of bucket or tube-like devices used to obtain water from either the surface or deeper underwater. However, it is important to make sure the bucket or tube device is not made of or contaminated with chemicals that may result in false detections of chemicals in the water. Laboratory analysis has become so accurate, with detection levels in the very low parts per million, parts per billion, even parts per trillion and parts per quadrillion, that proper sampling techniques are more important than ever.

Figure 10 Kemmerer water grab sample bottle

Figure 11 Van Dorn horizontal water grab sample bottle

Sediment sampling devices consist of various implements designed to grab sediment from the bottom of a water body. Some consist of long poles with a "clamshell" device on the end that closes and grabs the sediment. Others are weighted clamshells that are lowered into the water on ropes. Once the clamshell hits bottom, tugging on the rope causes the device to close and grab the sediment. Sediment samples are then sent to laboratories to determine if harmful chemicals are present in sufficient concentrations to cause harm to fish, macroinvertebrates, or humans.

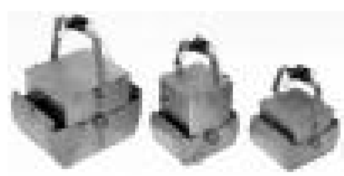

Figure 12 Ekman bottom grab samplers

Figure 13 Ponar bottom grab sampler

Figure 14 Van Veen bottom grab sampler

Flow or current meters are used to measure the speed of water flowing in a stream. This measurement along with measurements of the stream width and depth profile can be used to estimate not only the speed of the water but also the quantity of water moving past a given point on a stream. Flow measurements are usually given in cubic feet per second or CFS, and are known as a streams "discharge". A sluggish bayou may have a discharge of 0.1 or even 0 CFS if there has been no rain in recent days. By contrast, the Mississippi River's discharge ranges from about 200,000 CFS to 1,000,000 CFS. Discharge or CFS is important when estimating the quantity of various chemicals found in the water. This in turn is used by LDEQ to determine the amount of different pollutants that can be safely released into the water without harming aquatic life or humans. This determination is done using a mathematical model known as a Total Maximum Daily Load or TMDL. TMDLs are used to develop water discharge permits and to make recommendations regarding the prevention of nonpoint source water pollution. Taken together, these actions are designed to protect and improve the uses of water bodies in Louisiana.

Figure 15 US Geological Survey Pygmy flow meter

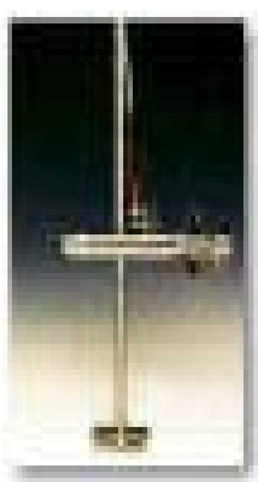

Figure 16 Wading rod flow meter

Figure 17 Columbus weight mounted flow meter

Threats to Water Quality in Louisiana

As most people realize, there are numerous threats to water quality in Louisiana and the nation. Fortunately, things are not nearly as bad as people frequently believe. Since 1972, the Federal Clean Water Act (CWA) has worked to protect and improve water quality in the United States. The CWA initially focused on cleaning up discharges of pollutants to water bodies by requiring industry of all sizes, cities, and towns to reduce or eliminate the amount of harmful chemicals in their wastewater. Yes, cities and towns contribute significant amounts of water pollution through their sewage treatment facilities. Largely as a result of the CWA, water quality in the United States is much better than it was 30 years ago. But there is still much work to be done. Nonpoint source pollution, which was described earlier, is now the largest single source of water pollution in the United States. This is largely because nonpoint source water pollution can occur anywhere and anytime it rains.

Mercury contamination of fish is currently a hot topic in Louisiana and the nation. This contamination results from a number of sources, but the largest single anthropogenic (man-made) source is coal-fired power plants. Coal contains low levels of elemental mercury. When coal is burned the mercury is released into the atmosphere where it travels in the air until falling out in rain or dust. Once this mercury reaches a water body it may be methylated, which changes the form of mercury into one that can be accumulated by animals in their bodies. As larger animals eat smaller ones the mercury builds up in their bodies in a process known as bioaccumulation. As a result, fish such as largemouth bass, bowfin (choupique), king mackerel, and other predatory fish can develop somewhat hazardous concentrations of mercury in their flesh. These concentrations are generally not high enough to cause harm to humans. However, pregnant women and small children are more at risk because mercury can permanently affect developing brains. Therefore, these populations must be more careful regarding the fish they eat and in what quantities. Likewise, commercial and recreational fishers who consume unusually large quantities of fish should review Louisiana’s fish consumption advisories to ensure they are not eating too many fish that may be contaminated with mercury or other chemicals. LDEQ is working with the Louisiana Department of Health and Hospitals and other State agencies to identify areas at risk due to mercury contamination of fish. The agencies then notify the public as to what fish are of concern and at what quantities they may be safely consumed. It is important when considering Louisiana’s fish consumption advisories due to mercury to read the details, because in many cases the average person can safely eat as much fish as they want. More information on mercury in fish can be found at:
http://www.deq.louisiana.gov/surveillance/mercury/index.htm

While mercury is a significant contributor to water pollution problems in Louisiana, the two most significant forms of water pollution are really pretty simply. They are low dissolved oxygen and sewage. Just like land animals, fish require oxygen to survive but they get their oxygen from the water through gills. If there is not enough oxygen in the water they can die or be forced to move to other areas of the water body. Low dissolved oxygen is caused when things such as fertilizer, sewage, or plants are present in the water in excessive quantities. Once in the water these things act just like fertilizer on a lawn or field, causing algae and other plants to grow rapidly. Two things can then happen. One, these plants can actually begin using oxygen in the water as they go through the process of respiration. Most people know about plants using carbon dioxide and giving off oxygen. But what most people don't know is that plants also taken in oxygen, especially at night, as part of their normal respiratory process. If there is too much algae growing in a water body it can actually cause oxygen levels to drop too low for the fish and macroinvertebrates living there. The second problem with excess plant and algae growth occurs after it dies and sinks to the bottom. When the algae die it decays as bacteria begin to eat it. This causes more and more bacteria to grow. Just like all animals, bacteria require oxygen to survive so if there are too many bacteria they can remove much of the oxygen from the water. This again makes it difficult for the fish to survive.

Sometimes the source of this low dissolved oxygen is simply nature in Louisiana. Swamps and marshes are naturally high in nutrients causing high levels of plant and algae growth. But this is not the problem. What can potentially harm Louisiana's water bodies is when humans dump too many nutrients in the water. Nutrients can come from a variety of sources, but the most frequent sources are farmer's fields, sewage treatment plants, home lawns, and other heavily fertilized areas. LDEQ works with all of these groups, either through regulations or through education to try and reduce the level of nutrients being released to Louisiana's waters. More information on dissolved oxygen in water can be found at: http://pathfinderscience.net/stream/cp4do.cfm, http://www.wavcc.org/wvc/cadre/WaterQuality/dissolve.HTM. (When reading through these links be sure to remember that 5.0 mg/L of oxygen is the norm for many other parts of the United States, and even parts of Louisiana. However, many of Louisiana's aquatic environments do just fine with natural concentrations of 4.0, 3.0, even 2.0 mg/L of oxygen, because the fish and macroinvertebrates here have adapted to survive and even thrive in this area.)

The second most significant form of water pollution in Louisiana is sewage. In addition to causing dissolved oxygen problems as described above, sewage can cause health problems for humans swimming in the water. Sewage frequently contains high levels of what are known as fecal coliforms. These bacteria are naturally found in the intestines of warm blooded animals, where they contribute to the digestion of food. Since they are found in animal intestines they naturally end up in the waste product of those animals. While fecal coliforms are not normally harmful by themselves, the presence of fecal coliforms may indicate the possible presence of harmful bacteria, viruses, and parasites that may be coming along for the ride. It is these harmful organisms that can cause illnesses should someone accidentally swallow contaminated water while swimming.

Fortunately, sewage treatment plants in Louisiana are regulated by LDEQ under the terms of the CWA, which was discussed earlier. Unfortunately, many cities and towns cannot afford to properly build or maintain their sewage treatment plants so that they adequately treat the sewage before it is released to area streams. Also of concern are the thousands of homes and camps located in Louisiana that use septic tanks or worse nothing at all before releasing their waste to the environment. In many parts of the State people feel it is okay to simply run a pipe to the nearest ditch or stream. Decades ago, when there were not as many people as there are now, this may have been acceptable. However, today there are so many people living along Louisiana's streams and lakes that many of them have become contaminated with sewage. Money often lies at the heart of the problem with both municipal sewage treatment systems and septic tanks. Everyone wants clean water for swimming and drinking but nobody wants to pay for it! More information on municipal sewage treatment and septic tanks can be found at: http://cecalaveras.ucdavis.edu/realp.htm, http://www.howstuffworks.com/sewer2.htm, http://people.howstuffworks.com/sewer3.htm.

A less recognized form of water quality impairment comes from invasive aquatic species. These are organisms, frequently plants but also mussels, mammals, and fishes, that have been accidentally or deliberately introduced to Louisiana's environment. Water hyacinth, salivina, hydrilla, zebra mussels, and nutria are all aquatic invasive species that are now causing extensive damage to Louisiana's water bodies and aquatic ecosystems. Invasive species generally grow at such a rapid pace that they tend to choke out native plants and animals that should be living in or around the water. In the case of nutria, they can quickly destroy marshes and trees or burrow into levees causing failures of these important structures. The State of Louisiana has developed an Aquatic Invasive Species Council to try and deal with this problem. The Council is composed of representatives of a number of State and Federal Agencies, along with industry and citizen groups who are charged with coming up with a strategy to address this problem. While many of these harmful species are here to stay, the Council is working to prevent more species from entering Louisiana, while trying to reduce the impact of the existing species. More information on aquatic invasive species can be found at: http://is.cbr.tulane.edu/, http://www.anstaskforce.gov/.

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